



The Scottish  
Government

BUILDING STANDARDS DIVISION

**A SIMPLIFIED APPROACH  
TO ALTERNATIVE FIRE  
SAFETY STRATEGIES**

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**Title:** A Simplified Approach to Alternative Fire Safety Strategies 1<sup>st</sup> Edition

Version	Date	Notes
1.0	08/10/10	First issue

# 1 - ESCAPE FROM BUILDINGS - A FRAMEWORK DOCUMENT

## INTRODUCTION

This document provides a common framework that will assist those involved in the design and approval processes to develop or assess alternative approaches to the guidance provided in Section 2: Fire of the Domestic and Non-Domestic Technical Handbooks.

### Background

The Technical Handbooks provide guidance on how to meet the mandatory building standards however, it is acceptable to use alternative methods for achieving compliance. Most new buildings, extensions, alterations or conversions, are of limited size or complexity and therefore do not merit the involvement of a fire safety engineer. However, the designer may wish, or need to consider, an alternative to the guidance in the Technical Handbooks.

The level of expertise required to use this document is intended to fall within the scope of a designer or verifier who can use their professional judgement to assess compliance with building regulations. However, users should have sufficient knowledge, training and experience of the basis of fire safety design and of the dangers involved.

Where there are a number of variations from the guidance in Section 2: Fire of the Technical Handbooks, a more detailed solution may be required to achieve the overall fire safety strategy for the building. If an alternative solution is considered in isolation, there is a risk that any previously established fire safety strategy for the building could be affected. **Caution should therefore be exercised and professional judgment made by the verifier or design team as to whether a detailed fire engineered solution is required. Guidance on such solutions is outlined in clause 2.0.7 of the Technical Handbooks (see flow chart on page 10 for further information).**

## 2 - AIM OF THE FRAMEWORK DOCUMENT

The aim of this document is to provide a common framework that will assist those involved in the design and verification of simple non-complex variations to the guidance provided in the Technical Handbooks for means of escape. This document should also help provide a consistency of approach by highlighting the underlying fire safety principles that need to be considered.

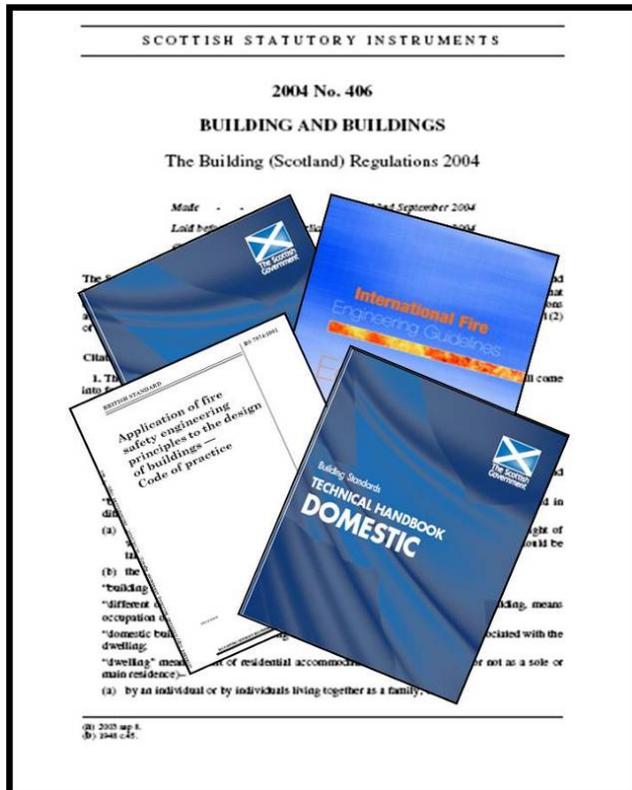
### What does the document contain?

Basic information that should be considered when identifying alternatives to the guidance. As well as references to other sources of advice that can be used to meet the requirements of the functional standards.

### Who is the document for?

Building design professionals, designing a new building, or extending, altering or converting an existing building, which does not exactly follow the guidance in Section 2: Fire of the Technical Handbooks. The document can also be used by verifiers in the process of considering the acceptance or rejection of design proposals. It is assumed that those using the document will have appropriate training, knowledge and expertise to be aware of the hazards and risks involved. The level of competency required will be dependent on the complexity of the fire strategy proposed for the building.

There are three levels in assessing the Fire strategy of a building:



**Level 1: Prescriptive** This level is appropriate to the majority of building warrant applications, and consists of meeting the guidance provided in the Technical Handbooks.

**Level 2: Performance** This is the level for which the guidance in this document is provided. It is intended to provide a more flexible fire design approach to satisfy the functional standards.

**Level 3: Fire Engineering** This level provides a fire engineered approach and may be the only practical way to satisfy the functional standards in some large or complex buildings, and in buildings designed for different uses. Detailed guidance on fire safety engineering is given in BS 7974: 2001 and in the International Fire Engineering Guidelines, see clause 2.0.7 of the Technical Handbooks.

The expertise required for a Level 3 fire engineered approach is far greater than that required for Levels 1 or 2 and should only be carried out by someone who can demonstrate the level of competency required, for example:

A Chartered Engineering Member of the Institution of Fire Engineers, or

- A person with a degree in Fire Engineering with appropriate training, knowledge and experience.

## **Roles and responsibilities**

Designers are tasked with the development of proposals that comply with the building regulations and satisfy client needs, within budget constraints. The verifier is responsible for granting or refusing building warrants and accepting or rejecting completion certificates. The intention is that the design is verified against each of the 15 building standards in Section 2: Fire; therefore, it is important to be aware that the verifier may initially query the proposal before it is accepted or rejected. The key issue for verifiers and designers to agree upon, is that the design solution meets the mandatory standard and achieves an equivalent level of safety as the Technical Handbook guidance. In order to achieve this objective, it is important that both parties work together and share a mutual understanding of each others role and responsibilities.

Regulation 11 of the Building (Procedure) (Scotland) Regulations 2004 identifies four building scenarios, which require consultation with the Fire and Rescue Services (FRS). These are:

- a) non-domestic residential buildings;
- b) non-domestic, non-residential buildings where the design does not follow the guidance in Section 2: Fire of the non-domestic Technical Handbook approved by Scottish Ministers;
- c) domestic buildings with a storey at a height of more than 18 m above the ground; and
- d) domestic buildings with a storey height more than 7.5 m but not more than 18 m above the ground where the design does not follow the guidance in Section 2: Fire of the domestic Technical Handbook approved by Scottish Ministers.

The FRS should also be given the opportunity to familiarise themselves with the design of the building including the active and passive fire precautions. This will greatly assist the FRS in determining their response as well as assisting operational staff to fight fires and effect rescue operations.

## 3 - THE OBJECTIVE

It is important to be aware that whatever safety measures are provided, be it by following the guidance or using an alternative solution to satisfy the functional standards, there is no such thing as 'zero risk'. The possibility of death or injury in a fire cannot be totally eliminated.

The standards dealing with means of escape are about limiting the risk to the occupants of a building following the outbreak of a fire. The intention of the standards is to ensure that the occupants have the opportunity to escape from the building or part of the building in relative safety following the outbreak of a fire and without assistance from the FRS. The FRS will carry out fire fighting and rescue operations when they arrive at an incident, but the fire strategy for the building should not be reliant upon the FRS attending within a specified time.

### DEVELOPING AN ALTERNATIVE APPROACH OR SOLUTION

Many of the fire safety features in a building are inter-related and weaknesses in some areas can be compensated by strengths in others. Some projects involve variations from the guidance and simple methods of proving equivalence can be adopted. A comparative study can be carried out against the guidance provided in the Technical Handbooks. The objective is for verifiers and designers to agree that the design solution achieves at least, the equivalent level of safety, as the guidance in the Technical Handbooks.

**Example 1** – The guidance within section 2.9 of the Technical Handbooks recommends that an escape route should have a headroom of at least 2 m. Certain buildings, such as a shop or office may have a higher ceiling that can act as a smoke reservoir and it may be possible to allow extended travel distances due to the longer time available before conditions become untenable. Professional judgement can be used to assess if the time available for escape is sufficiently increased to compensate for the increased travel distance (see examples 5 and 6 for further information).

Whilst it is desirable for occupants to escape before any fire or smoke spreads into escape routes, this is not entirely achievable in most designs. For example, smoke can descend to below head height from a ceiling or roof or leak into escape routes around gaps in doors or service openings. The intention of functional Standard 2.9 is to inhibit smoke spread to such an extent as to allow escape in relative safety.

The advice of a fire engineer should be sought for complex solutions as each stage in the evacuation process may need to be analysed to ensure the available safe escape time (ASET) is greater than the actual time needed to reach a place of relative safety i.e. required safe escape time (RSET).

In some circumstances this exercise may prove that little, if anything, is required to be undertaken to ensure adequate means of escape even though the building solution may not be the same as that given in the Technical Handbooks.

### Building Information

Basic information that should be considered within the wider strategy is:

- a) what are the likely occupancy types? i.e. the life risk;
- b) what will burn and how will it burn? i.e. the fuel load and smoke hazard;
- c) what is the nature of the construction and the geometry of the building? i.e. the building hazard;
- d) what are the fire safety measures provided in the building?; and

- e) how will the building be managed and will this contribute to the level of fire safety for the specific circumstances?

**Example 2** - A large building containing vast quantities of combustible material (e.g. a warehouse) could be described as a high damage hazard because if a fire did occur, the destruction of contents and structural damage might be considerable. However, the personal risk would be low because of the limited occupancy capacity and also the likelihood that the occupants will be awake and familiar with the escape route. Theatres, cinemas and other places of public assembly, even though their combustible content may be low, must be considered to present a high personal risk primarily because of the large number of people involved.

It is important not to assume that a building poses a high risk to personal safety simply because there is a large fuel hazard.



**Warehouse with large amount of combustible material but limited number of occupants and ignition sources**

## 4 - ESCAPE PROCESS

### Escape Process

All buildings must provide safe and effective means of escape to allow occupants the opportunity to vacate the building. Ideally all occupants should be able to directly reach a place of safety however, due to the size and complexity of many buildings this is not always possible. If necessary, occupants may be safeguarded by the provision of fire containment measures in the building which place a fire resistant structure between occupants and the fire. This will allow additional time for escape, to a place of safety.

Escape from fire is a continuous route starting from any point within the building where the occupants may be and ending at a place of safety. There could be up to four stages in the process of escape:

- stage 1** escape from the room or area of fire origin;
- stage 2** escape from the compartment of fire origin by a circulation route to a final exit, entry to a protected stair, or to an adjoining compartment offering refuge;
- stage 3** escape from the floor of fire origin to the ground level; and
- stage 4** final escape at ground level.

### Reasonable Worst Case Fire Scenarios

It will normally be necessary to agree the reasonable worst case fire scenarios with the verifier. Assumptions should be challenging, but not overly pessimistic. For example, a single seat fire can be assumed at ignition, while a simultaneous failure or breakdown in passive and active fire precautions is considered to be a catastrophic event and an unlikely scenario. However, the probability of some degree of system failure should be considered, especially for higher risk buildings such as residential buildings, assembly and entertainment buildings.

**Example 3** - The suppression system has been accidentally shut-off or the compartment wall is breached due to inadequate fire stopping. Clearly, where systems are properly checked and maintained (e.g. by third party verification or maintenance agreements), then a degree of confidence can be placed on system reliability. Where such an arrangement is in place, this should be recorded and be part of the fire strategy of the building.

Fire safety measures introduced to reduce the fire risk of the hazard, (e.g. automatic suppression system), cannot be viewed in isolation. The interaction of each measure must be known and the overall impact of such measures considered.

### Occupancy Characteristics

An understanding of the characteristics of the occupants will suggest their likely speed of travel and in conjunction with the predicted speed of fire growth, enable adequate means of escape to be designed. In some buildings, the occupants may be vulnerable because of their age or infirmity and it may not be possible to evacuate the entire building immediately. In non-domestic buildings, for example shops, assembly buildings and entertainment buildings, the occupants may be unfamiliar with the building layout and may not immediately perceive themselves to be at risk.

It may be the case that occupants delay their evacuation because they may not be aware of an outbreak of fire in the building or may not perceive themselves to be at risk from the fire. There is a need therefore, for a range of fire safety measures to protect occupants from the effects of

fire and smoke, and allow them time to reach a place of safety. The importance of these different factors will vary depending on the type of occupancy, the layout of the building and the distribution and awareness of the occupants.

**Example 4** - The evacuation of people with disabilities from upper floors can pose additional difficulties. It may be necessary to consider safe areas to wait temporarily, before being assisted to escape by trained staff e.g. 'buddy system' (see paragraph on travel distance).

The document - *Practical Fire Safety Guidance – The evacuation of disabled persons from buildings*, issued by the Scottish Government provides information and guidance on fire evacuation of disabled persons from buildings.

## Occupancy Load Factors

The nature and numbers of occupants is probably more influential than certain physical design factors emphasised in the Technical Handbooks. In certain cases the occupancy capacity given in the Technical Handbooks can result in a conservative layout and it may be possible for the designer to demonstrate an occupancy lower than that recommended. The occupancy load factors are used to indicate the minimum area occupied by each person. But it can be difficult, in some buildings, to determine the numbers of people accurately. In shops for example, the occupancy density can change, with areas of low occupancy density becoming high density at different times of the year. Certain building types with shared occupancies or where there is a mix of users, such as hospitals with patients, staff and visitors, pose additional problems and should be considered separately.

## Communications Systems

Interactions of the communication system with the occupants (e.g. fire alarm and voice communications systems), the effectiveness of signposting, clarity of the internal layout and routes, the quality of fire safety training, and housekeeping and staff/occupant response, all help minimise the risk to life from fire. The provision of an automatic fire alarm and detection system can significantly increase the time available to escape by providing early warning of fire so that occupants start to make their escape sooner. When considering the overall escape time from a building, occupant reaction to an alarm can be more important than the time it takes to physically reach an exit.

Building management and emergency signage are out with the scope of building standards however, it is essential to be aware of their importance and the relevant legislative requirements (see clause 2.0.8 of Technical Handbooks). The provision of an adequate number of staff who have received effective fire safety training can be the best first line of defence against fire. The presence of trained staff who can respond quickly and effectively to any fire emergency is a vital factor in limiting the consequences of a fire, particularly in hospitals where dependent patients are involved.

## Key Occupant Characteristics

Five key characteristics of occupants need to be considered:

- a) **sleeping risk** - if the occupants are asleep their ability to detect a fire and to escape quickly will be greatly impaired;
- b) **numbers** - where there are large number of occupants there may be problems of overcrowding, misinformation or confusion;
- c) **impairment** - the occupants may suffer from mobility, visual, hearing or other impairments which reduces their ability to escape quickly;

- d) **familiarity** - if large numbers of the occupants are unfamiliar with the building then they may not necessarily use the nearest escape route; and
- e) **response** - in some situations the occupants may not recognise the fire alarm, may assume it is a false alarm, or may respond inappropriately.

## **Fuel load**

The fuel loads within buildings vary enormously and it is insufficient for the designer to treat all buildings identically. Building uses are defined in Appendix A of the Technical Handbooks and these reflect, to some extent, the fire loads of different building functions. Designers and verifiers should understand the principles of fuel load and how changes in fuel and/or ventilation conditions can affect the time available to escape. Due to the complexities involved, such an approach would normally be part of a fire engineered solution and is outwith the scope of this document.

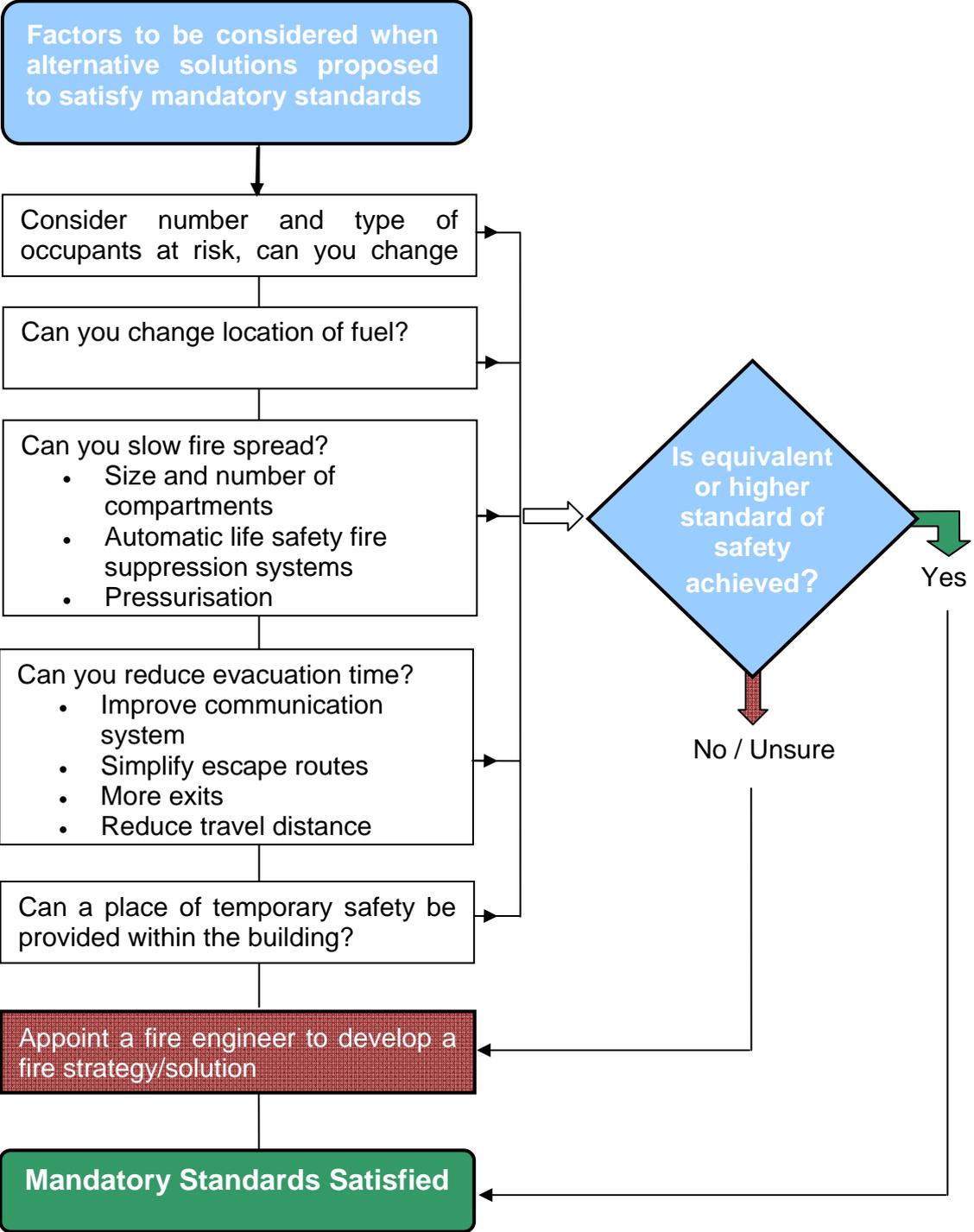
## **The building geometry**

The speed at which a space becomes untenable is mainly dependant on its volume and the growth rate of the fire. For higher and larger spaces the time it takes to fill with smoke is longer, so there may be more time available to escape and longer travel distances could be possible. The guidance in the Technical Handbooks does not take into account such particular design features, which could allow a degree of flexibility without compromising safety.

**Example 5** - High ceilings can act as a reservoir for the smoke to allow safe egress beneath the smoke layer. In such buildings the advice of a specialist fire safety engineer should be sought especially if smoke calculations are provided to verify that safe egress can be achieved (see example 6 for additional guidance). How a building is sub-divided can also have an impact on occupants ability to escape safely. A building with cellular rooms served by long unprotected corridors with low ceilings can present a greater risk to building occupants than large open plan spaces. This is because there is a greater probability of an undetected fire developing and the time to untenable conditions in the corridor would generally be far less than for a large open plan space (see page 16 for guidance on smoke control).

## 5 - CONSIDER OPTIONS

This flow chart sets out five key design factors that can influence alternative solutions for compliance with mandatory standards. For each of the design factors, the guidance that follows provides a structured approach and identifies the risks.



## 6 - CHANGE THE LOCATION

The design factors identified in Section 5, along with the interaction between escape, containment and suppression, with communication playing the central role, will be considered in turn below.

### CHANGE THE LOCATION OF PEOPLE WITHIN THE BUILDING

The **first factor** is to re-design the building changing the location from which people have to escape therefore reducing evacuation time. In some instances this may be difficult, but it might be that the building includes a number of different uses e.g. office space only during daytime, residential space at all times. If this is the case then it might be possible to reposition areas where escape is most difficult e.g. sleeping areas to more accessible parts of the building nearer exits.

### CHANGE THE LOCATION OF THE FUEL LOADS WITHIN THE BUILDING

The **second factor** is to re-design the building and to change the location of high fuel loads. The likely fuel load within buildings varies enormously and designers should not regard all buildings as identical. The nature of the fuel load will have a significant impact on the rate of growth and spread of the fire. If there are areas or rooms which, because of their function, contain high fuel loads, then these should be located as far as possible from high risk life areas or enclosed by fire resisting walls, floors and doors. If this is not possible then consideration should be given to changing the nature of the fuel load.

It is unlikely that the contents of the building can be altered significantly since these will be determined by the function of the building. However, the designer should be able to control the construction fabric, fittings and to some extent the furnishings. The fittings should be chosen for their fire resistant and retardant properties and the furnishings should be chosen from those which have been tested to the appropriate standards.

It may be possible to re-locate specific materials or working practices to mitigate ignition sources. Generally, it is considered that there is a fire load throughout the building. Any statement that there is nothing to burn will need strong supporting evidence if the design is to be accepted by the verifier.

## 7 - SLOW FIRE SPREAD

The **third factor** is to slow the spread of fire, to allow more time for escape. The time available for escape should, in all cases, be greater than the time required for escape if the building is to be a safe one. This can be achieved in a number of ways:

**Smaller compartments** - Compartmentation provides fire resistant structures that can be used to give protection from the effects of fire and smoke. It consists of fire tight cells designed to prevent the spread of fire by limiting the fuel available in the initial stages of the fire by the introduction of a series of fire resistant barriers which form the compartment boundary. Designing in this way should limit the spread of fire giving occupants the opportunity to escape and will also assist the fire and rescue services. For more detailed guidance refer to functional Standard 2.1, 2.2 and 2.14 of the Technical Handbooks. Compartmentation also helps protect the rest of the property while the fire is extinguished and is therefore important both for life safety and property protection.

Containment measures provide:

- a safe resting place where occupants can wait temporarily before continuing with their escape;
- a safe area away from the source of the fire where, occupants can remain until advised to evacuate if necessary (see guidance to functional Standard 2.9 with regards emergency voice communication system); and
- a place from which fire fighters can prepare to attack the fire.

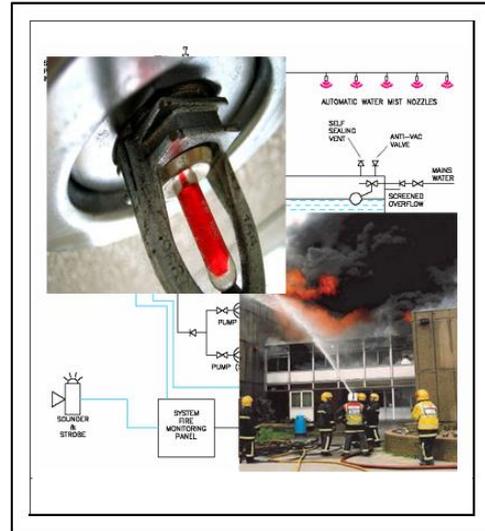
Additionally, reducing the compartmentation size can improve the means of escape by reducing the distance occupants have to travel to reach a fire resistant wall that gives direct access to a place of safety, either directly or via a protected zone, or an adjacent compartment. For more detailed guidance refer to section 2.9 of the Technical Handbooks.



The fundamental principle for designers to remember is that the integrity of the sub-dividing elements must be maintained and there can be no weak points or cavities which compromise the fire and smoke barrier. Any services or ducts which breach the compartment walls or floors must be designed to provide an equal level of fire resistance. A major threat to the fire safety of a building can come from the late addition of services or ducts which are cut through compartment walls breaching critical fire barriers. The protection of cavities is particularly important as these can provide routes for the rapid unseen spread of flame and smoke without occupants being aware. Any doors in compartment walls should maintain the fire resistance of the walls.

**Suppression** - One way of helping control fire spread is the installation of an automatic fire suppression system as part of the fire safety measures for the building. Automatic fire suppression systems have the ability to not only detect and signal the outbreak of a fire, but also to physically fight it. An automatic fire suppression system affords the greatest protection to occupants outwith the room of fire origin.

There are a number of different automatic fire suppression systems available and the suitability of each type will depend on a range of factors, including the type of fire likely to be encountered. Such a system would be installed to either suppress the fire when small, or control it to limit its growth.



The feasibility and likely success of automatic fire suppression systems will depend upon:

- the geometry of the building;
- the function of the building (the undertaking of hazardous operations or the storage of hazardous goods);
- possible interactions between the automatic suppression systems and any ventilation control systems;
- the specification of the automatic fire suppression system; and
- possible water damage due to the operation of the suppression system (however it must be remembered that while sprinklers will wet a small fire, the Fire and Rescue Service, when they arrive, will deluge a large fire and water damage may be proportionally greater).

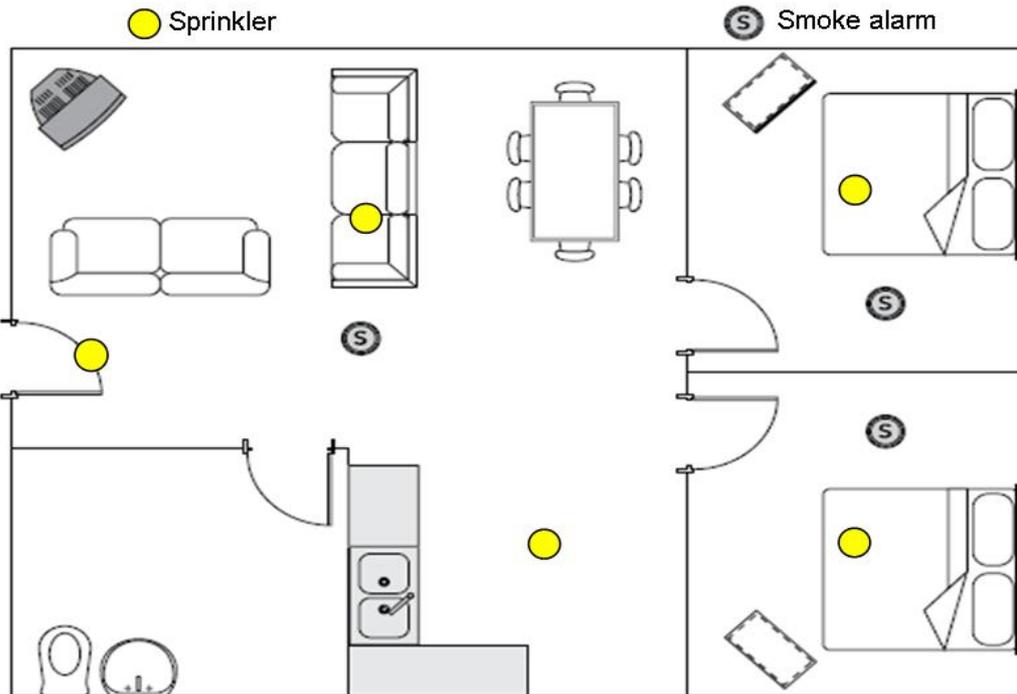
The system installed should not be viewed in isolation but considered as part of the overall fire safety measures in a building. For more detailed guidance refer to functional Standards 2.1 and 2.15 of the Technical Handbooks.

When designing a building the nature of the combustible materials being stored within will determine the most effective extinguishing medium (water, foam, powder, gas). However, it should be remembered that suppression can fail due to defective equipment or bad staff practices e.g. forgetting to turn the system on again after maintenance. It is also important that regular maintenance and checks are undertaken to ensure the effectiveness of the system.

The most common suppression medium is water delivered by a sprinkler system. In addition to providing a system to help control, or in some cases extinguish a fire, an automatic fire suppression system can also give warning of the fire.

The technical requirements for fire suppression systems in domestic buildings are covered by BS 9251: 2005, whilst the Loss Prevention Council's Rules for automatic sprinkler installations incorporating BS EN 12845: 2004 (as amended) gives details relating to various non-domestic applications.

Two main options for sprinkler installations are direct mains-fed systems and systems that have water storage and pumps.



### Open plan layout incorporating automatic fire detection, alarm and suppression system

- a mains-fed system is significantly less expensive, not as complex and requires less space than a pumped system; however, there are limitations on its use. Specifically the mains water pressure and flow rate in the area must be such that the water supply can serve the sprinklers, as well as giving a degree of confidence in the continuity and reliability of the service. Scottish Water must be consulted and flow rates and pressures should be measured near the point at which it is intended to make the connection. It must be recognised that water pressure may vary at different times through the day and night and may change in the future. Therefore it is imperative that the system is designed on the basis of what the minimum pressure and flow is likely to be. If there is any doubt a tank and pump arrangement should be used.
- if the mains water supply is inadequate or does not exist e.g. in a rural location where the building is served by a private water supply, then it may be necessary to use a system with a storage tank and pumps. Often a standby power supply or a pump driven directly by a diesel, or similar, generator is required for these systems so that the pumps can operate during a power failure.

**Smoke control** – Smoke control can reduce the potential effects of smoke, heat and fire. Smoke ventilation of escape routes can be provided by:

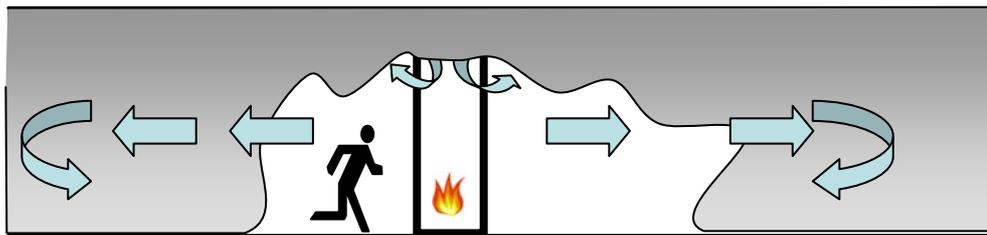
- natural smoke ventilation; or
- mechanical smoke ventilation.

The principal forms used are smoke venting by depressurisation, i.e. the removal of the smoke from the affected area either by natural or mechanical means and pressurisation, the exclusion of smoke from particular areas, especially stairways or corridors, by the creation of a positive pressure.

**Example 6** – The guidance in section 2.9 of the Technical Handbooks recommends that auditoria are provided with a form of smoke control designed to reduce smoke movement from the stage towards the auditorium. Auditoria, such as theatres, contain large numbers of the

general public as well as stage areas with high fire loads. The intention behind the recommendation is to increase the time available for occupants of the auditorium to escape in relative safety. Some auditoria such as lecture theatres typically contain a significantly lower fire load than theatres, for example stage areas which are limited to a lectern and a projection screen, and consequently smoke control is not normally required.

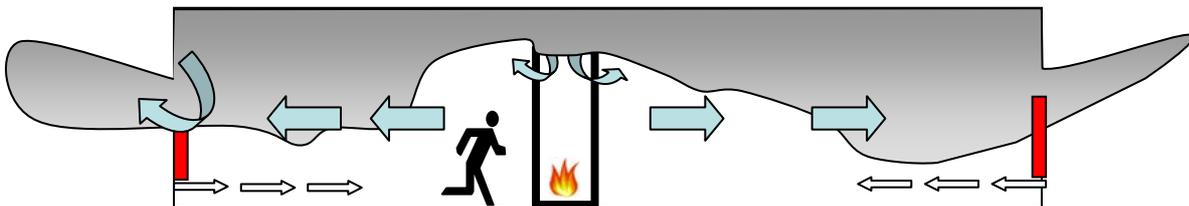
**Escape routes/smoke ventilation** - Although buildings can have physical barriers to fire such as walls, floors and doors, there is still a risk of smoke spread into escape routes. Therefore, smoke ventilation may be provided to help maintain tenable conditions within escape routes during evacuation of the building and to assist fire-fighting operations by allowing smoke clearance.



**Recirculation of smoke in an unvented corridor**

The fire and rescue services may be in attendance before the building has been evacuated. Therefore it is important that the smoke ventilators, including powered systems, are capable of being opened, closed or shut off by fire and rescue personnel to assist them with their fire-fighting and rescue operations. For more detailed guidance refer to functional Standard 2.14 in the Technical Handbooks.

**Escape routes/natural smoke ventilation** - Natural ventilation uses external openings in the roof or walls of the building to remove smoke. Due to its higher temperature smoke is less dense than the surrounding cool air and therefore rises. The efficiency of a natural smoke ventilation system depends upon the location of the ventilator and the direction and velocity of the prevailing wind. Under certain wind conditions, the smoke flow through ventilators may be enhanced whilst under other wind conditions, it may be impaired. Ideally, the location of ventilators should be positioned on the building in negative pressure zones, with any air inlets in the positive pressure zones however, this is difficult to achieve for all wind directions.



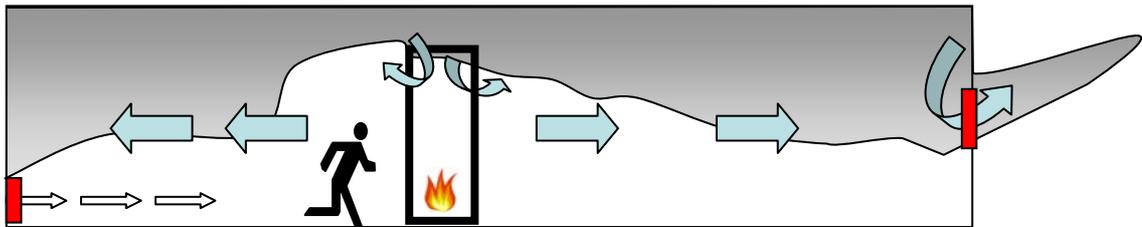
**Smoke being drawn and diluted by air drawn in through ventilators**

Roof pitches more than 30° may result in a positive wind pressure on the windward slope of the roof, which could lead to the pressure developed by the smoke layer not being sufficient to overcome the downward pressure of the wind. This would result in the ventilator acting as an inlet rather than an exhaust. More detailed guidance is available in BRE document 368, Design methodologies for smoke and heat exhaust ventilation.

**Escape routes/mechanical smoke ventilation** - Mechanical smoke ventilation may be used to inhibit smoke spread into *escape routes* by means of:

- depressurisation systems; or
- pressurisation systems; or
- smoke and heat exhaust ventilation systems.

The merits and limitations of each should be assessed before deciding which system to choose. More detailed guidance on the design of smoke control systems using pressure differentials is available in BS EN 12101: Part 6: 2005.



**Smoke being drawn out by mechanical ventilation with inlet air supply**

**Depressurisation** - A depressurisation system is based on the principle of extracting smoke to the outside air. This creates a negative pressure in the space or the area of fire origin relative to the adjacent spaces. The intent is to remove and avoid the spread of smoke to adjacent spaces and escape routes. Where a depressurisation system is used, replacement air should be provided to enable the system to operate effectively. The volume of air and smoke removed should be replaced with the equivalent volume of replacement air at a sufficient rate in order to ensure a smoke flow out of the building. Reducing the rate of replacement air can result in the smoke ventilation system becoming less efficient whereas increasing replacement air at high velocities can produce air pressure conditions which make doors difficult to open. The system should be balanced to ensure that the forces required to open doors are not greater than those specified in Section 4: Safety of the Technical Handbooks.

**Pressurisation** - A pressurisation system is based on the principle of forcing air into the escape route which helps to keep smoke out. Forced air can be used to maintain a positive pressure in the escape route which produces an air flow through gaps around doors and prevents smoke from entering. The system design should take account of likely pressure reduction when occupants open doors to escape or when fire-fighters open doors to access the fire. The system should be balanced to ensure that the forces required to open doors are not greater than those specified in Section 4: Safety of the Technical Handbooks.

**Smoke and heat exhaust ventilation systems (SHEVS)** – These systems can comprise natural, mechanical or hybrid ventilation methods to control heat and smoke in the room of fire origin for large rooms or spaces such as enclosed shopping centres, atria, enclosed car parks and theatres. By creating a smoke free zone the SHEVS also assists the fire and rescue service in their fire fighting and rescue operations. SHEVS are used to control the rate of smoke exhaust and keep the smoke layer at a safe height to avoid harmful smoke and radiated heat affecting escaping occupants.

As smoke is exhausted replacement air is necessary and inlets should be located below the smoke layer to avoid disturbance of it by cooling or creating turbulence. A SHEVS cannot control the fire growth; therefore sprinklers may also be necessary to provide for safe occupant evacuation. If a building is sprinklered then the operation of either the SHEVS or the sprinklers should not compromise the function of the other. More detailed guidance on the design of SHEVS is available in BS 7346: 4: 2003; and for enclosed shopping centres in Annex 2C of the Non-Domestic Technical Handbook.

**Heating and Ventilation Systems** - It is important that ducted heating and ventilation systems, including air conditioning systems installed to maintain interior environment conditions, that serve the building should not transfer fire and smoke from; any compartment to any other compartment, common space, roof space concealed space or escape route. Heating, ventilation and air conditioning systems should not compromise the function of any smoke ventilation systems. Therefore, in the event of an outbreak of fire, the heating and ventilation system should automatically either shut off, or operate in smoke control mode. In any case, its function should be integrated with any smoke ventilation system that serves the escape routes. For more detailed guidance refer to BS 5588: Part 9: 1999.

**Increase the volume to cope with the smoke spread** - The speed at which fire grows within an enclosed space depends not only on the available fuel, but also on the geometry of the space. Fire growth will tend to be quicker in more confined spaces, provided there is an adequate oxygen supply, due to the faster temperature rise. Large volume spaces with high roofs have the advantage of possibly slowing the fire growth while permitting the smoke to rise sufficiently high so that it is immediately apparent to those within the affected space, and escape remains possible below the smoke layer, for some time.

The calculations related to fire growth and smoke spread are fairly complex in anything other than single large spaces and the results generated can only be crude approximations as to what is most likely to occur. Therefore, although this may be a viable alternative it is one where the advice of a specialist fire safety engineer is important. For more detailed guidance refer to clause 2.0.7 of the Technical Handbooks.

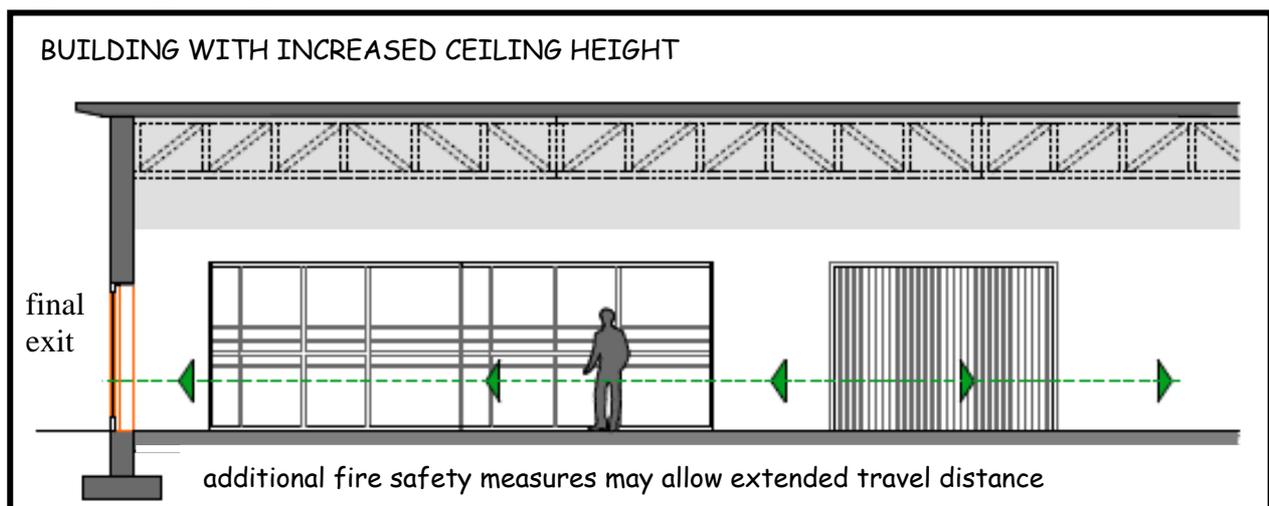
**Example 7** - As discussed in examples 1 and 5, buildings with high ceilings can act as a reservoir for smoke. This may help in the evacuation process by allowing safe egress beneath the smoke layer and allow for longer travel distances to be considered by the verifier.

In assessing such a design layout there are various factors that a verifier may consider such as:

- height of the ceiling;
- openings in the ceiling;
- number and location of exits;
- occupancy capacity;
- does the area being assessed have an open play layout, which gives clear sight lines to exits;
- nature of the occupants, i.e. their mobility and awareness;
- additional fire safety features installed in the building for example, automatic fire alarm and detection system.

To verify that safe egress can be achieved, smoke calculations may be required to identify the time until untenable conditions are reached. For such complex solutions the advice of a fire engineer should be sought and are outwith the scope of this document.

### High ceiling acting as smoke reservoir



## 8 - REDUCE EVACUATION TIME

The **fourth factor** is to reduce the evacuation time for the building occupants, so that the time available for escape will be greater than the time required for escape. This can be achieved in a number of ways.

**Communications** - Pre-movement time, or the time it takes occupants to recognise and respond to a fire alarm, is a major component of escape and can often be the longest period of the total escape time. The sooner the evacuation process starts the more time is available and therefore longer travel distances might be considered reasonable.



Communications systems are closely linked to the means of escape. When fire breaks out it is important that it is detected as fast as possible. The exponential rate of fire growth means that, the earlier action can be taken to mitigate the consequences of ignition, the greater the possibility of success. Human detection can be faster than an automatic

detection system, provided there are people in the vicinity, who are awake and capable of reacting to a fire.

Automatic detection is based on identifying the products of combustion (e.g. heat, flames or smoke). The effectiveness of automatic detection will depend upon the type of sensors and their location in relation to the building's geometry and contents. Having detected a fire it is then a question of interpreting that signal. There are various detection devices on the market from simple manual call points to detection devices which are part of an addressable system. Such systems have small reliable microprocessors allowing the results from each device in a system to be interrogated to obtain information on the performance of detector heads. These systems give both greater accuracy in the analysis of fire effects and an ability to identify faults. It is also necessary that automatic detection is maintained correctly.

When an automatic fire detection and alarm system is installed as part of an alternative solution, an enhanced system is usually necessary. An assessment of the determined use of the building should be carried out taking into account how the building will be evacuated in order to specify the appropriate alarm category for the circumstances concerned.

**Example 8** - The category chosen may be to compensate for a simple departure from the guidance in a single room within a building. Such a departure may only require a system that incorporates the installation of an automatic fire detector in that room which will alert the occupants of both the room and the building.

**Example 9** – Limited extension to the travel distances recommended within the Technical Handbooks may be acceptable, where a more comprehensive detection system is provided throughout a building. An enhanced fire alarm and detection system can reduce the response time of occupants, however, the building use, familiarity of the occupants with evacuation procedures, and how quickly they are likely to respond to a fire alarm, must also be considered.

Other than in very small buildings, consideration should be given to making the fire alarm and detection system fully addressable (i.e. so that individual detection devices can be uniquely identified at the fire alarm panel/s). This will give building occupants and the fire-fighters precise information about the areas of the building affected by fire. The various categories of life safety fire alarm systems are specified in BS 5839: Part 1: 2002.

The guidance within BS 5839: Part 1: 2002 recommends that in order to direct those responding to a fire alarm signal, particularly the duty-holders (e.g. staff), and the fire and rescue service, to the area of a fire, *“all buildings, other than very small buildings, need to be divided into detection zones.”* Even if the fire alarm system is addressable, it recommends that zone indicators should be provided, *“as this often provides a quicker, albeit less specific, indication of the location of a fire than typical addressable text displays.”*

The two main options for a fire detection system are:

- fully wired installations; and
- wired installations with radio interlinking.

Radio interlinking is regarded as a reliable alternative to wired interlinking between detectors, and guidance is given in BS 5839 (Part 1 2002, Part 6 2004). The advantage of radio interlinking is that it is not necessary to run fire-protected cables to all the devices. These systems can therefore be installed with limited disruption to the building fabric.

BS 5839 (Part 1 2002, Part 6 2004) provides guidance for the design requirements of such a system. Radio installations reduce significantly the need to run cables within the construction and when this is done during a conversion, the additional disruption will be minimal. Radio-linked components forming part of a BS 5839-1: 2002 fire alarm system all contain individual batteries. While this reduces the cabling needed, the ongoing replacement of batteries over the life of the system will need to be properly costed and managed. This aspect should be given due consideration as part of the selection process. The following points should be noted:

- the smoke alarms should be connected to the mains supply; and
- the radio-interlinking should not reduce the battery life of an alarm when the power is down; and
- the verifier and fire and rescue service should be satisfied that the potential for accidental false alarms has been managed.

If it is considered that people may not respond quickly to a fire warning, or where people are unfamiliar with the fire warning arrangements, consideration should be given to installing a voice alarm system. Such a system can form part of a public address system and give both an audible signal and verbal instructions in the event of fire.

Research would suggest that this can be an effective method of initiating an evacuation in public buildings. This can be part of a sophisticated alarm system which can also alert the FRS so that they can start fire-fighting and rescue operations, and trigger any automated response such as an active smoke control system, closing fire doors, or triggering a local suppression system. It is important that designers consider the communication system as a whole rather than as isolated pieces of engineering. The system should provide a network from discovery of the fire, to the information being delivered to each occupant, the FRS and the management. It is equally important for designers to understand the risks posed by unwanted actuations and how to minimise them. For more detailed guidance refer to functional Standard 2.11 of the Technical Handbooks.

**Simplifying escape routes** - It is clear from the study of previous major disasters that where the escape routes are simple and obvious there is a greater chance of them being used effectively in a fire. In some buildings it may be desirable for the occupants to escape from the building by the route they entered and only if this route is blocked or untenable will they use an alternative, provided the alternative is as clear and obvious as the primary route. If possible all staircases should be fire escape staircases and lead, via safe routes, to the outside. Larger spaces may speed up escape by permitting direct sight of final exits and a clear appreciation of the overall situation. The provision of emergency lighting, which will operate should the normal

lighting in escape routes fail, can help to illuminate the escape routes. Way finding systems and low level lighting can provide assistance to occupants in conditions of smoke obscuration. For more detailed guidance, refer to functional Standard 2.10 of the Technical Handbooks.

**Escape Route Widths** - Travel distance is related to the time to escape to a place of safety or protected zone and is therefore a major component of the guidance given for escape under Standard 2.9, along with the number, location and width of exits.

It is important to realise that evacuating occupants from a building is dependent not only on the time it takes to reach an exit but also on the number that can be discharged through an exit in a given time. For this reason the guidance recommends that the effective width of an escape stair should be at least the width of any escape route giving access to it to help limit the potential for queuing at the storey exit. When calculating the effective width of escape stairs the guidance in Section 2 Fire of the Technical Handbooks allows a reduction to be made for the provision of protected lobbies, this results in a decrease in the width of the escape stair. However, as there is no corresponding allowance for the reduction made in the calculation of the horizontal width of the escape this can result in both the horizontal and the vertical escape route widths being determined by the horizontal width calculation.

**Stair Widths** – The guidance supporting Standard 2.9 of the Technical Handbook provides examples on calculating stair widths, based on either phased or simultaneous evacuation.

The provision of additional fire safety measures such as compartment floors, automatic fire detection and voice alarm can allow phased evacuation to be adopted. This will allow a reduction in the required width of the escape stairs, by evacuating occupants most at risk first, followed by occupants in other compartments. Further guidance on phased evacuation procedures is provided in Section 9 of this document.



Simultaneous evacuation is necessary in buildings that do not have the appropriate measures required for phased evacuation, such as compartment floors or a suitable automatic fire detection and alarm system. This method of evacuation is based on all occupants evacuating the building simultaneously on activation of the fire alarm, consequently resulting in the need for wider stairs. The method of calculating the escape stair widths for simultaneous evacuation in the guidance to Standard 2.9 of the Technical Handbook can be used to reduce the width of the stair as it rises up the building.

**Example 10** – If the designer chooses not to reduce the widths of the escape stairs as they rise up the building, it may be appropriate to use alternative guidance to calculate stair widths for simultaneous evacuation. One of the most common alternative approaches involves time based egress calculations. This is based on the concept that the available safe escape time (ASET) is greater than the actual time needed to reach a place of relative safety i.e. required safe escape time (RSET). However, for such complex solutions the advice of a fire engineer should be sought.

**Additional Exits** - The behaviour of people caught in fire is unpredictable therefore the travel distances recommended in the table to Standard 2.9 of the Technical Handbooks needs to include a sufficient factor of safety, to limit the distance occupants may have to travel in fire conditions especially in buildings where occupants may be unfamiliar with the escape routes. Ideally occupants of a building should be able to make their escape before there is an appreciable development of fire or smoke. The provision of an automatic fire alarm and detection system can reduce the time taken for occupants to begin their evacuation. The factor of safety provided in the recommended travel distances aims to reduce the time needed for occupants to reach an exit or protected zone. Due to the varying speeds of travel of occupants, in some cases this may result in the occupants having to queue at the exit, though it does not necessarily mean that it will have an impact on their ability to escape before being overcome by fire or smoke. The controlling factor will be the exit width and the siting of those exits.



**Additional exit created below an existing window**

**Example 11** - It is quite possible that with certain building types, travel distances longer than that proposed in the guidance to Standard 2.9 of the Technical Handbooks, may be provided e.g. in a building with an automatic fire alarm and detection system of a higher standard than recommended under the guidance given for Standard 2.11 or a building with a smoke extraction systems etc. This type of design solution is already an accepted method of compliance within enclosed shopping centres. The more exits provided in appropriate locations that are easily recognised, the safer a building is. It is important also to consider the provision of access points for fire fighting and rescue operations as occupants using these exits can impede fire and rescue access.

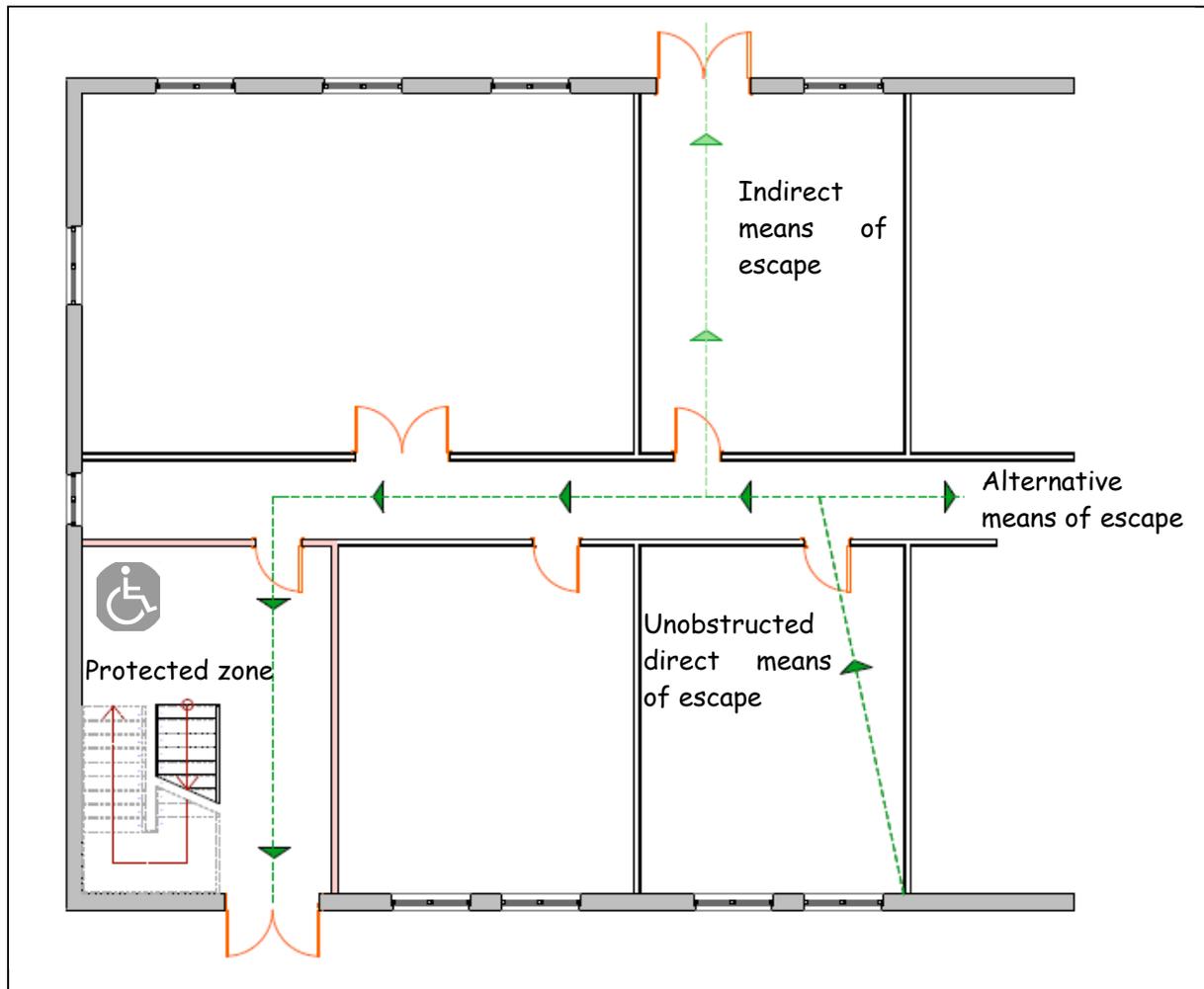
The guidance in the Technical Handbooks sets out a fire safety solution based on the provision of a certain number of exits. If this number is exceeded to such an extent that the evacuation time will be reduced, then it may be reasonable to discount other aspects of the means of escape strategy.

**Example 12** - The maximum occupancy of many places of public entertainment is set by assigning a floor area per occupant however, it would not be unreasonable to exceed this maximum occupancy load provided the number of exits provided and their distribution are sufficient for the anticipated figures and geometry of the space; e.g. by the complete replacement of an external wall with doors at ground level. Such an approach would only be suitable for buildings where the occupants are familiar with the building or can easily be controlled, as crowding and confusion could result at areas other than the exit. The critical criterion is to ensure that the conditions through which occupants have to escape do not exceed tenability limits.

**Travel distance** – In an escape route there may be two zones, the ‘*unprotected zone*’ which includes the distance across the room from which the person is exiting, together with any distance along a corridor, to reach a protected door giving access to the ‘*protected zone*’. The distance traveled within the unprotected zone is called the travel distance.

Escape routes should be available at all times and be via a direct and unobstructed path. Once occupants have left a room they should normally not have to pass through another room to reach a protected zone or place of safety (for inner rooms see guidance in Section 2: Fire of the Technical Handbooks). Escape routes need to be obvious and should be designed with this in mind. In low rise buildings such as offices, where the occupants are awake and familiar and can be expected to escape unaided, the occupant densities tend to be low compared with the escape route capacity. In such buildings, a fire strategy may propose that escape is via another room to reach a protected zone or a place of safety; see diagram below.

### Example of a means of escape via another room in an office building



In a building where the occupants have a choice of more than one direction of travel, the guidance in the Technical Handbooks provide recommendations on travel distance depending on the occupancy profile expected in a building. In an office for example, when there is more than one direction of travel, it is recommended that the occupants should not have to travel more than 45 m to reach an exit.

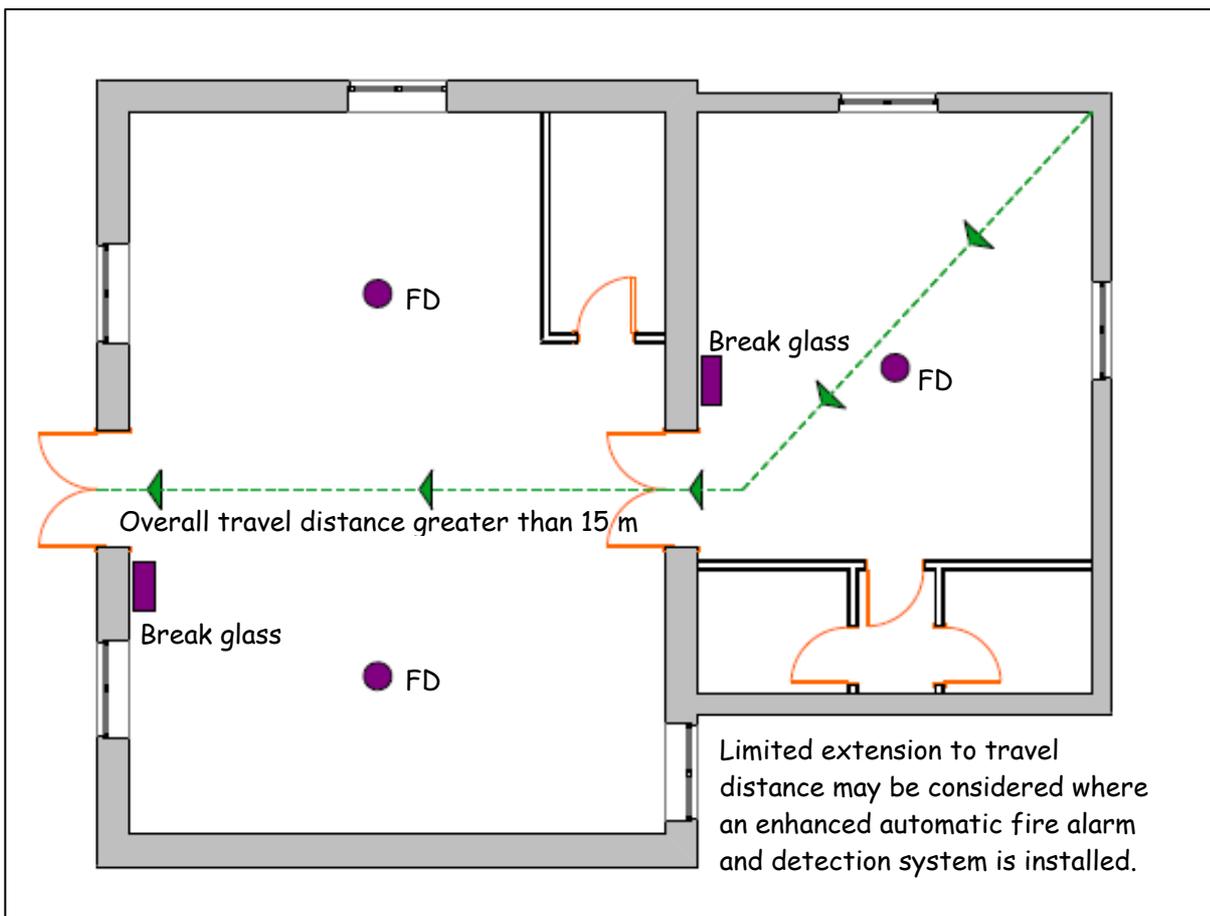
The general principle with travel distance, is that when an alternative escape route is provided and the occupants cannot use the nearest exit, they will travel to the next exit. This could result in occupants in buildings such as offices, having to travel up to 90 m to reach an exit.

It is difficult to regulate the location of exits by simple egress capacity calculations. The use of the travel distance recommendations does, to a certain extent, control their distribution along with occupancy capacity and alternative directions of escape.

In buildings with fixed seating, such as an auditorium, occupants may need to make their way to an exit via a seatway and gangway before they have the opportunity to diverge. In rooms of this type the seatway and gangway travel distances, can therefore be combined before diverging to two exits provided the guidance under clause 2.9.9 'Direction of escape' is considered.

As a general principle, travel distances should be kept as short as possible however; this does not mean that extending travel distances beyond that stated in the Technical Handbook would lead to an unsafe condition. Much will depend on the circumstances; in a small restaurant e.g. it may be acceptable for a limited extension to the travel distance due to the installation of an enhanced automatic fire alarm and detection system, see diagram below.

### Limited extended travel distance from an inner room to a final exit



**Occupancy risk factors** - A performance based system allows for the introduction of fire safety measures to justify extending travel distance. These could be an automatic fire alarm and detection system, an automatic fire suppression system, a suitable smoke control system or a large smoke reservoir in the roof space.

In order to arrive at an appropriate travel distance it is important to assess the life risk. The examples below will help both the designer and verifier in the assessment of the occupancy risk factors, and whether any fire safety measures, proposed as compensatory features, adequately reduce the risk. Although the risks identified are not exhaustive they can be used to arrive at a travel distance based on the occupancy and building type.

Due to the impracticality of setting out precautions necessary for every possible type of occupancy, the guidance in the Technical Handbooks classifies the different building types according to the occupancy profile and fuel load which have been assumed as constant for that building type. It should be noted that some occupants may also have sensory, cognitive and/or mobility impairments that could create difficulties in perceiving or responding to a fire or in evacuating the premises. Alterations may have been made to the premises to improve accessibility and egress for disabled persons in accordance with the Disability Discrimination Act. The following building types are examples of how the life risks need to be considered:

- a) Residential buildings: the occupancy capacity is reflected by the number of bedrooms and the management of the building should have an appropriate method of alerting occupants to a fire under functional Standard 2.11. Occupants are particularly vulnerable to fire when asleep and the level of fire risk increases at night. Occupants may also be unfamiliar with their accommodation and escape routes. This can particularly be the case with hotels when guests arrive late at night.
- b) Offices: occupants will be awake, familiar with the premises and are unlikely to be so engaged with the task at hand that they initially fail to perceive or respond to an outbreak of fire in their immediate area. The life risks that should be considered as part of the fire safety evaluation include ensuring that the number and location of exits are sufficient for the occupants. Depending on the building's configuration, height, occupancy capacity, and occupancy mix, an automatic alarm system may be needed.
- c) Shops: occupants will be awake and are unlikely to be so engaged with the task at hand that they initially fail to perceive or respond to an outbreak of fire in their immediate area. In large department stores with restaurants or cafeteria, a delay in the initial evacuation may be possible therefore suitable measures should be set in place to address this potential life risk. The life risks that should be considered as part of the fire safety evaluation include, ensuring that the number and location of exits and escape routes are sufficient for the occupant capacity and that sufficient fire safety measures are in place to assist those occupants who are unfamiliar with the building.
- d) Assembly buildings: occupants will be awake and are unlikely to be so engaged with the task at hand that they initially fail to perceive or respond to an outbreak of fire in their immediate area. The life risks that should be considered as part of the fire safety evaluation include ensuring that the number and location of exits and escape routes are sufficient for the occupants and that sufficient measures are in place to assist occupants unfamiliar with the building. In assessing the likely occupancy capacity for such buildings it is important to be aware of the differences in audience behaviour. For example pop concerts may attract large numbers of, excitable persons and require a greater degree of control and stewarding than other events such as a play performed in a large theatre which attracts a more orderly audience.
- e) Factory or storage buildings: occupants will be awake and familiar with the building. Due to the varied nature of these buildings some may contain hazardous or dangerous materials or processes, with the potential for fire or explosion posing an additional risk to persons within, or in the immediate vicinity of, the premises.

These life risks should be considered as part of the fire safety evaluation to ensure that appropriate measures are in place to safeguard occupants who are so engaged with the task at hand that they may initially fail to perceive or respond to an outbreak of fire in their immediate area.

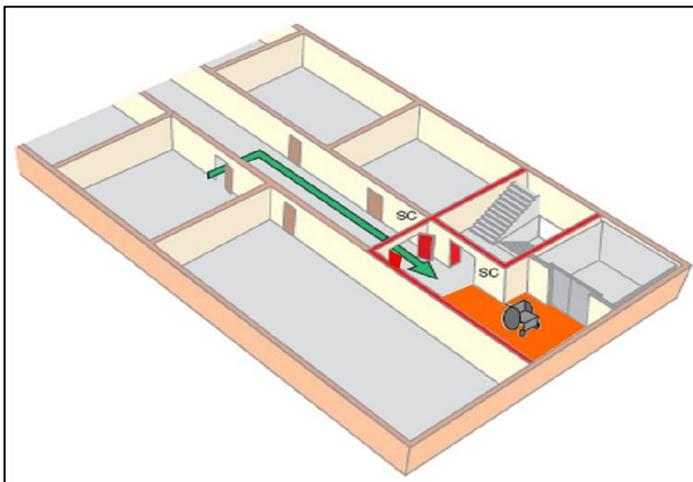
f) Car parks: occupants will be awake and are unlikely to be so engaged with the task at hand that they initially fail to perceive or respond to an outbreak of fire in their immediate area. The occupancy capacity of car parks is low as is reflected in the recommended load factor (see clause 2.9.2 of the Non-Domestic Technical Handbooks). Life risks that should be considered as part of the fire safety evaluation include ensuring occupants are aware of escape routes. Generally occupants will only be familiar with the route from their car to the door taking them into the building.

If the building is accessible to occupants with sensory, cognitive and/or mobility impairments then difficulties in perceiving or responding to a fire or in leaving the premises should be appropriately addressed. The document - *Practical Fire Safety Guidance – The evacuation of disabled persons from buildings*, issued by the Scottish Government provides information and guidance on fire evacuation of disabled persons from buildings.

As identified in the introduction, the interaction of each measure must be considered and the overall impact of such measures considered.

## 9 - DESIGNING PLACES OF TEMPORARY SAFETY

The **fifth factor** is to introduce a place (or places) of temporary safety within the building. The normal escape strategy is simple direct escape from the building when the alarm is sounded. However, a temporary waiting space protected by fire containment can be introduced within the building. Evacuation can then initially take place from the area of fire origin to an adjoining compartment, rather than directly to the outside. Such a space is only acceptable when it is possible to continue with further evacuation, should that be necessary, without returning to or having to go through the compartment of fire origin.



Due to the height of high-rise buildings, the fire must be contained and eventually extinguished from within the building. The fire may be below the occupants and the distances to ground level might be too great. In some buildings it may be necessary to provide temporary waiting spaces, which are intended for occupants to remain in throughout the fire. For example, intensive care departments or high dependency units in hospitals are normally designed on such a principle. Although ultimately escape to a place of safety outside the building may be necessary. There must be escape from any temporary waiting space other than returning through the fire affected areas.

There are a number of factors which have to be considered when evacuating occupants with sensory, cognitive and/or mobility impairments:

- Compartmentation
- Phased evacuation
- Communications
- Building features

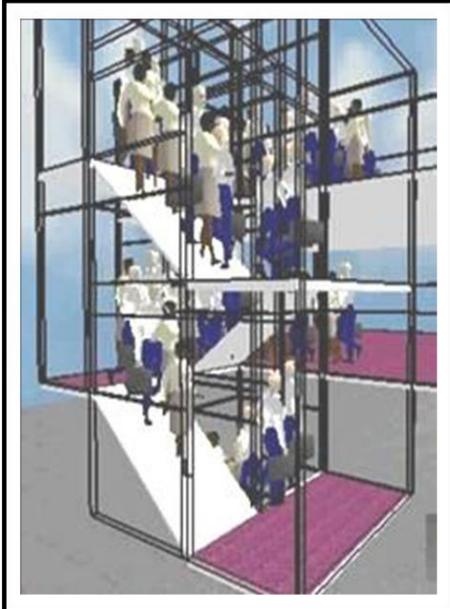
**Compartmentation** - The provision of adequate compartmentation is needed to provide the necessary fire resistant barriers to protect any part of a building. Compartmentation may also be used to afford a place of temporary safety within the building. In the event of fire, occupants with sensory, cognitive and/or mobility impairments making their evacuation unaided can be much slower than other building users. Therefore, such occupants should be given the opportunity to take the route which offers them a greater period of safety. This may be through an adjacent compartment where the occupants may remain until the fire has been extinguished, or if necessary, continue evacuation to a place of safety. The intent is that further evacuation may be carried out under less pressure of time. There must be escape from any temporary waiting space other than returning through the fire affected areas. There can never be dead ends from which there is no escape.

**Example 13** - In hospitals, where the means of escape are designed on the principle of progressive horizontal evacuation, patients are moved from one compartment or sub-compartment to the next on the same level. The intent is that patients are progressively moved in a direction of travel away from the fire. Protection is given by the increasing number of compartment and sub-compartment walls between them and the fire.

Designers should therefore consider whether phased or simultaneous evacuation is needed in the building. Consequently the passive and active systems should mirror the escape philosophy.

Compartmentation may have to be aligned with the fire safety engineering systems such as two stage alarms in a building with common escape routes. Common spaces can permit rapid smoke spread between compartments. To reduce the possibility of smoke spread, openings between compartments should be protected (see functional Standards 2.1 and 2.9 of the Technical Handbooks for further guidance).

**Phased evacuation** - In a compartmented building the designer can take into account the fire



resistance of the construction, enclosing the escape stairs in a protected zone and the fire safety measures provided to allow the width of escape to be based on phased evacuation. Such fire protection measures reduce the risk of fire and smoke spreading between storeys and gives occupants additional time to make their escape or seek refuge until the fire is extinguished.

In phased evacuation the occupants evacuated first are those with sensory, cognitive and/or mobility impairments and those on the fire floor and the storey immediately above. If further evacuation is required this is done on the basis of the next two adjoining upper storeys or adjacent compartments. Phased evacuation can be of advantage for managing the evacuation of occupants with sensory, cognitive and/or mobility impairments as well as minimising disruption in large buildings.

The preferred method of evacuation for occupants with sensory, cognitive and/or mobility impairments is initially by horizontal evacuation. In buildings that require vertical escape some occupants may not initially be able to self-evacuate and may require a combination of evacuation options for example:

- structural fire containment, (compartmentation, temporary waiting spaces etc);
- suitably designed evacuation lifts (see guidance below);
- building features (communication system, flashing beacons, colour coding/contrasting on escape routes etc);
- management procedures (meet assistance, evacuation chair, doors opened, identification of escape routes etc).

For phased evacuation it is essential that both the occupants on the storeys affected by fire and smoke and occupants on storeys remote from the fire are given sufficient information to allow such a strategy to be effective. Factors that should be considered when assessing what category of fire alarm or automatic fire detection system is to be provided will vary widely from one premises to another. Where the means of escape is based on phased evacuation, a staged alarm system is appropriate. This enables two or more stages of alarm to be given within a particular area e.g. alert or evacuate signals.

The success of such an approach depends on the provision and maintenance of a package of fire safety measures. For more information on management see Section 10 of this document.

**Communications** - In a building designed with temporary waiting spaces or phased evacuation the communication systems must provide clear and unambiguous advice to the occupants to avoid uncertainty and panic. Interfaces between parts of the building receiving different

messages must be carefully considered and trained staff should be used to aid communications.

The guidance in Section 2 Fire of the Technical Handbooks covering temporary waiting spaces recommends that in order to assist the escape process and reduce the anxiety of occupants an emergency voice communication [EVC] system should be provided. For more information see the guidance to functional Standards 2.9 and 2.11 of the Technical Handbooks.

**Lifts** – In general it is not appropriate to use lifts when there is a fire in the building because there is always the danger of people being trapped in a lift that has become immobilised as a result of the fire. This may be due to fire damage, power failure, water damage from fire-fighting operations or smoke logging.

However, purpose designed evacuation lifts and fire-fighting lifts have features and safeguards which may allow their use in the event of fire. Evacuation lifts may be used to evacuate people who might have difficulty using other escape routes such as stairs. Where evacuation lifts are intended to be used, the occupants can use the emergency voice communication system (EVC) on the lift landing to contact and inform the person co-ordinating the evacuation of the storey they are waiting on.

The following non-exhaustive list contains some of the issues that would need to be considered if lifts are to be used as part of a means of escape in the event of a fire:

- will sufficient well-trained staff be available to control use of the lift?
- how will occupants be informed and reassured that an evacuation lift is available?
- what measures will be taken to inform and reassure occupants when they will be evacuated and the lift will remain operational during the fire?
- how will the lift evacuation be sequenced if there are occupants on more than one floor who require access to the lift?
- how will the power supply to the lift remain usable throughout the time required for evacuation?
- how will the lift enclosure and associated escape routes remain free from the effects of fire, heat and smoke during the evacuation?

The provision of good communication and appropriate training for management and staff regarding the use of evacuation lifts are vital. There should be clear procedures to allow communication between those waiting for lifts and the fire wardens or those at the emergency control centre so that the evacuation can be coordinated as effectively as possible.

The use of lifts for evacuation should also allow for the FRS to carry out fire and rescue operations. They may need to override the system in order to use one or more lifts to access the fire and these lifts would normally be returned to their access level and park. When under FRS control, these lifts could no longer be called to a floor by the building's occupants and would therefore only be available for evacuation purposes in the early stage of the evacuation process.

**Consultation with the FRS must be carried out regarding the use of evacuation lifts and their interaction with fire-fighting and rescue operations.**

Where an evacuation lift is provided it should be designed and constructed in accordance with the guidance below:

- lift well enclosed by compartment walls with at least medium fire resistance duration;
- an emergency voice communication system (EVC);
- the evacuation lifts should be clearly identified by appropriate fire safety signs;

- the lift should include an 'evacuation lift' switch, for operation of the lift by an authorised person;
- the lift should be adjacent to an alternative escape route and temporary waiting space;
- The lift should have a duplicated power supply comprising a primary electrical supply obtained from a sub-main circuit exclusive to the lift and an alternative emergency power supply such as an automatically started generator.

More detailed guidance on the design and construction of evacuation lifts can be found in BS 8300: 2009, BS EN 81-1: 1998 or BS EN 81-2: 1998, BS EN 81-70: 2003 and BS 5588: Part 8; 1999. Guidance on emergency voice communication systems (EVC) can be found in BS 5839: Part 9: 2003.

**Signage and orientation information** - Using existing elements within the building may help occupants to facilitate their own evacuation. Features of good building design with reasonable adjustments such as good colour contrasting, handrails on escape stairs; contrast to the nosings on the stair treads; markings on escape stairs; colour contrasted or different texture floor coverings on escape routes; or way-finding information will all aid escape from a fire. Orientation aids, tactile information and audible signs, flashing beacons and pagers may further reduce the need for assistance. Where audible signals are used, any potential interference by the fire alarm operation needs to be considered. Inclusion of these elements within escape routes can reduce the need for assisted evacuation.

**Management features** – Fire safety legislation in Scotland places the responsibility of those persons who have control of, or safety obligations in respect of, premises that require a fire safety risk assessment, to ensure that arrangements are in place for safe evacuation. Responsibility for evacuation cannot be delegated to the Fire and Rescue Service. Each building should have an emergency fire action plan specifying the evacuation procedures for everyone, in and likely to be in, the building.

The safe egress and evacuation of occupants with sensory, cognitive and/or mobility impairments requires careful consideration and attention. The arrangements should be compatible with the general evacuation strategy and the emergency fire action plan for the premises. The responsibility for implementing the plan and evacuating persons safely in the event of an emergency will rest with duty-holders.

An evacuation plan for occupants with sensory, cognitive and/or mobility impairments must not rely upon the intervention of the Fire and Rescue Service to make it work. It is important that staff and managers fully understand both the evacuation plan and fire safety strategy for the building so that they can render maximum assistance to occupants with sensory, cognitive and/or mobility impairments, irrespective of the nature of their impairment.

**Additional Guidance** - The document - *Practical Fire Safety Guidance – The evacuation of disabled persons from buildings*, issued by the Scottish Government provides information and guidance on fire evacuation of disabled persons from buildings.

## 10 - MANAGEMENT

**Management systems** – The management of a building is an integral part of a fire strategy. While it is outwith the scope of the Building (Scotland) Act 2003, the attention of developers and builders is drawn to the importance of providing the occupants with information on the use of the equipment and on its maintenance.

The Fire (Scotland) Act 2005 Part 3, makes provision in relation to fire safety. A fire strategy will outline the responsibilities and duties of the staff including what role they may have in the event of a fire i.e. assisting occupants, use of fire extinguishers, maintenance etc.



A fire strategy is a 'live' document and should be adjusted as and when the fire safety audit identifies new risks or when modifications to the building are made that may impact on fire safety. It will also set out the programme for full and regular fire safety audits of the building and all its fire safety systems and components. Such an audit will allow any new risks to be identified and appropriate measures taken to offset those risks.

Once the building is in use it is the responsibility of the occupier to maintain the fire safety measures in an appropriate manner. For a satisfactory maintenance regime a clear understanding of the Fire Strategy is necessary. Adequate means of access should be provided so that it is possible to carry out routine inspections and maintenance (such as testing and cleaning) of active and passive fire safety measures easily and safely. It is essential to ensure that future changes to the building do not negate the effectiveness of the fire strategy.

**Independent Schemes of Certification and Accreditation** – The use of 3rd party certification is being increasingly specified by designers, contractors, local authorities and facility managers. This is because it is seen as providing some reliance with regards to the attestation of construction products and in some cases, their installation during the construction process. Some organisations and companies operate schemes for accreditation of materials, products and/or installers. Whilst these schemes are not an alternative to formal building regulation approval, they may be accepted by local authority verifiers as evidence of compliance with the requirements of the building regulations.

The performance of a system, product, component or structure is dependent upon satisfactory site installation, testing and maintenance. Third party accredited product conformity certification schemes may provide a means of identifying materials and designs of systems, products or structures which have demonstrated that they meet the requisite performance in fire. They can provide confidence that the systems, materials, products or structures actually supplied, are provided to the same specification or design as that tested/assessed, thereby increasing the reliability of the anticipated performance in fire.

It is essential to ensure that future changes to the building do not negate the effectiveness of the system to which the certificate applies.

**Historic buildings** – The document – *Practitioners Guide: Protecting Historic Buildings from Fire*, issued by Historic Scotland provides information and guidance on issues that impinge on the need to provide fire safety measures into historic or traditional buildings. It is divided into two parts. Part I is primarily devoted to the identification of the issues that may arise, while Part II provides considerably more detail on the types of systems, equipment and material which are available to provide compliant fire safety measures and also addresses the way in which fire safety should be managed in historic or culturally valuable buildings.

The Guide is intended to provide guidance on issues surrounding the application of the fire safety measures contained in The Building (Scotland) Regulations 2004 as they relate to traditional buildings especially those which have been listed as being of historic or architectural importance. The Guide will also be of value in the management of fire safety in such properties as well as in respect of properties where the contents of the buildings may be of cultural or historic value.

**11 - APPENDICES**

<b>APPENDIX A</b>	
<b>FACTORS AND SYSTEMS TO BE CONSIDERED</b>	<b>DESIGN CONSIDERATIONS</b>
<b>Function of room</b>	Assembly room – Office – Bedroom – Shop – Workshop - Intermittent occupation (warehouse)
<b>Geometry of space</b>	Height of ceiling - Amount of ventilation - Open plan - Cellular offices - Galleries
<b>Containment measures</b>	Lines of compartmentation / sub-compartmentation - Fire resistance duration - Cavity barriers - Fire stopping (ducting, openings etc.) - Automatic suppression systems
<b>Number of means of escape</b>	Occupancy load - Building height - Occupancy characteristics - Travel distance
<b>Occupancy numbers</b>	Maximum number expected in a space considering use of space, for example whether seated, standing, low density occupancy etc.
<b>Travel distance</b>	Travel distance to protected door - Alternative direction of escape - Number of occupants and their characteristics (Sensibility, Reactivity, Mobility, Susceptibility) - Whether a communication system is installed - Familiarity of the building - Occupancy awareness - Life safety management strategy of the building
<b>Exit capacity</b>	Number, capacity and location of exits - Evacuation strategy
<b>Evacuation strategy</b>	Phased - Simultaneous - Progressive horizontal evacuation
<b>Escape routes</b>	Travel distances to protected door - Number, location and widths of exits - Number and widths of stairways - Temporary waiting spaces - Communication system - Escape lighting - Location of fire fighting lifts
<b>Automatic systems</b> i. Smoke control ii. Suppression iii. Communication iv. Smoke & heat ventilation	Purpose of system, (compensatory measure or additional fire safety measure) - Type of system, (life safety, property protection) - Can it be manually overridden (fire and rescue service intervention) - Is there a maintenance regime in place - Life time of system
<b>Protecting openings</b> i. Fans ii. Vents	Fire doors – Dampers – Shutters - Magnetic hold open devices
<b>Materials</b> (use of non-combustible materials)	Construction - • Linings and fixings

**APPENDIX B**

**ASSESSMENT SHEET**

<p><b>Procedure</b></p> <ol style="list-style-type: none"> <li>1. Has adequate documentation been provided?</li> <li>2. Have the objectives been clearly stated i.e. life safety, property protection, sustainability?</li> <li>3. Has "plausible" in terms of "reasonable" criteria been established and understood by the verifier?</li> <li>4. Have the assumptions been explained in sufficient detail?</li> <li>5. Are there any management assumptions?</li> </ol>	<p><b>Documentation requirements</b></p> <ol style="list-style-type: none"> <li>6. Has the relevant certification been provided? (Automatic fire suppression systems, automatic fire alarm and detection systems, smoke control systems, smoke curtain tests etc)</li> <li>7. Does the documentation include all relevant records, criteria, test reports, and source document references?</li> <li>8. Do drawings show the important details?</li> <li>9. Is there sufficient explanation of the reasons for decisions made in the design process?</li> <li>10. If a continuing requirement has been applied to the building has the relevant information been made available to the Duty-holder or Fire Safety Manager of the building?</li> </ol>
<p><b>Design</b></p> <ol style="list-style-type: none"> <li>11. Have the relevant standards/guidance been properly interpreted?</li> <li>12. Is it clear that the standards have been satisfied?</li> <li>13. Are there any unstated assumptions?</li> <li>14. Are all the key assumptions adopted clearly stated, and are they explained in sufficient detail?</li> <li>15. Has the design taken into account the practicalities of its implementation including the construction phase?</li> <li>16. Has a factor of safety been applied?</li> <li>17. Has the need for a reasonable worst case scenario/sensitivity analyses been considered?</li> <li>18. Is the type and purpose of each fire safety measures, (both passive and active) stated?</li> <li>19. Does acceptance of completion depend on commissioning and/or acceptance of tests?</li> <li>20. Has the allowance for "safety margins" been made clear? (The designer should not assume that the design will be implemented perfectly).</li> </ol>	<p><b>Competency</b></p> <ol style="list-style-type: none"> <li>21. Has every design been signed off by an appropriately qualified or experienced person?</li> <li>22. Is the compliance check being carried out by appropriately qualified staff?</li> <li>23. Designs that include special features which require specialist knowledge are outwith the scope of this framework document?</li> <li>24. Computer models are outwith the scope of this framework document.</li> <li>25. Calculations are outwith the scope of this framework document.</li> </ol>